WNAT/WQNZ

SM-110 SERIES
FREQUENCY COUNTER

595-1502-03

OPERATION/SERVICE
MANUAL

HEATH
Schlumberger

HEATH
Schlumberger

SM-110 SERIES
FREQUENCY COUNTER

595-1502-03

SM-110A

SM-110B

SM-110C

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Section 1

INTRODUCTION AND SPECIFICATIONS

The SM-110 Frequency Counter Series is a new generation of precision frequency measurement instruments with expanded capabilities. Each counter contains two separate inputs for high and low frequency measurement, while a sensitivity control allows input trigger level selection above the signal zero-crossing level in the low frequency channel. The low frequency input is designed for high impedance sources up to 65 MHz. The high frequency input will direct count 50 Ω sources up to 200 MHz. In addition, the Model SM-110C contains a prescaler which allows measurement of frequencies up to 600 MHz.

Display for these instruments consists of seven 7-segment LED (Light-Emitting Diode) arrays and an LED overrange indicator. The LSD (least significant digit) remains valid even though the MSD (most significant digit) is beyond display range. Conversely, leading zero blanking is provided when less than seven digits of data is displayed.

Each counter has the same basic clock frequency of 1 MHz. The SM-110A contains a conventional crystal clock, while the SM-110B and SM-110C have a temperature-compensated crystal clock for increased stability. On all units, a rear panel connector is provided for connection of external clock frequencies such as a 1 MHz standard for precision measurements, or a second signal for Frequency-Ratio determination. A front panel switch allows control of the time base for a gate interval of 10, 1, 0.1, or 0.01 seconds.

The SM-110B and SM-110C are fully programmable. Two rear panel connectors provide BCD (binary-coded decimal) information of the display and allow complete programming of all instrument functions except power OFF and external oscillator. This includes programming of four additional gate intervals: 1 ms, 100 μs, 10 μs, and 1 μs.

Rugged compact design, ease of operation, and exceptional accuracy combine to make this Counter an invaluable tool for a wide range of electronic measurements.

NOTE: The SM-110C is an FCC type approved frequency measurement instrument for AM and FM standard transmission.

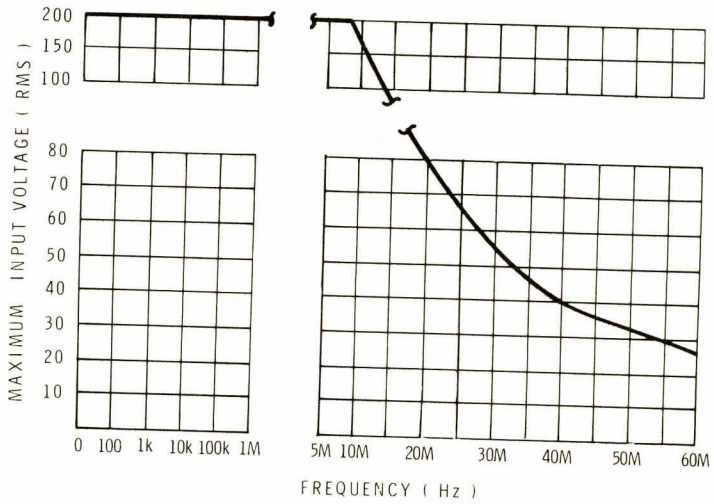


Figure 1-1 A Input derating curve.

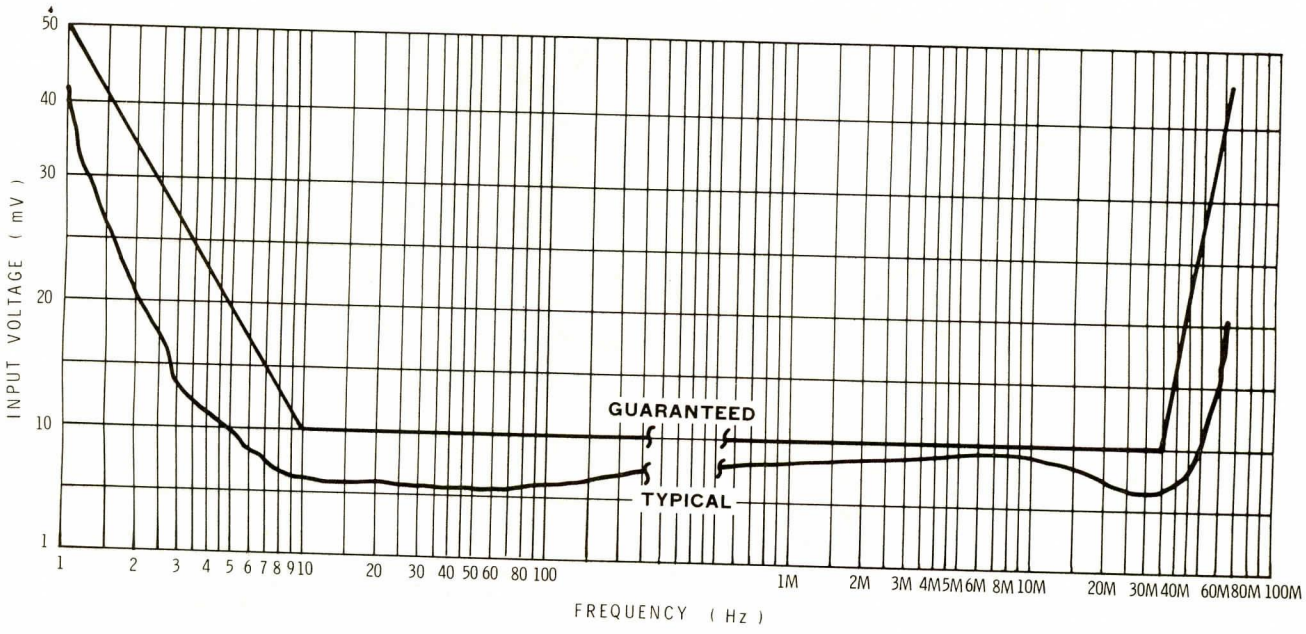


Figure 1-2A Input frequency response curves showing typical and guaranteed response with the Sensitivity control in the Preset position.

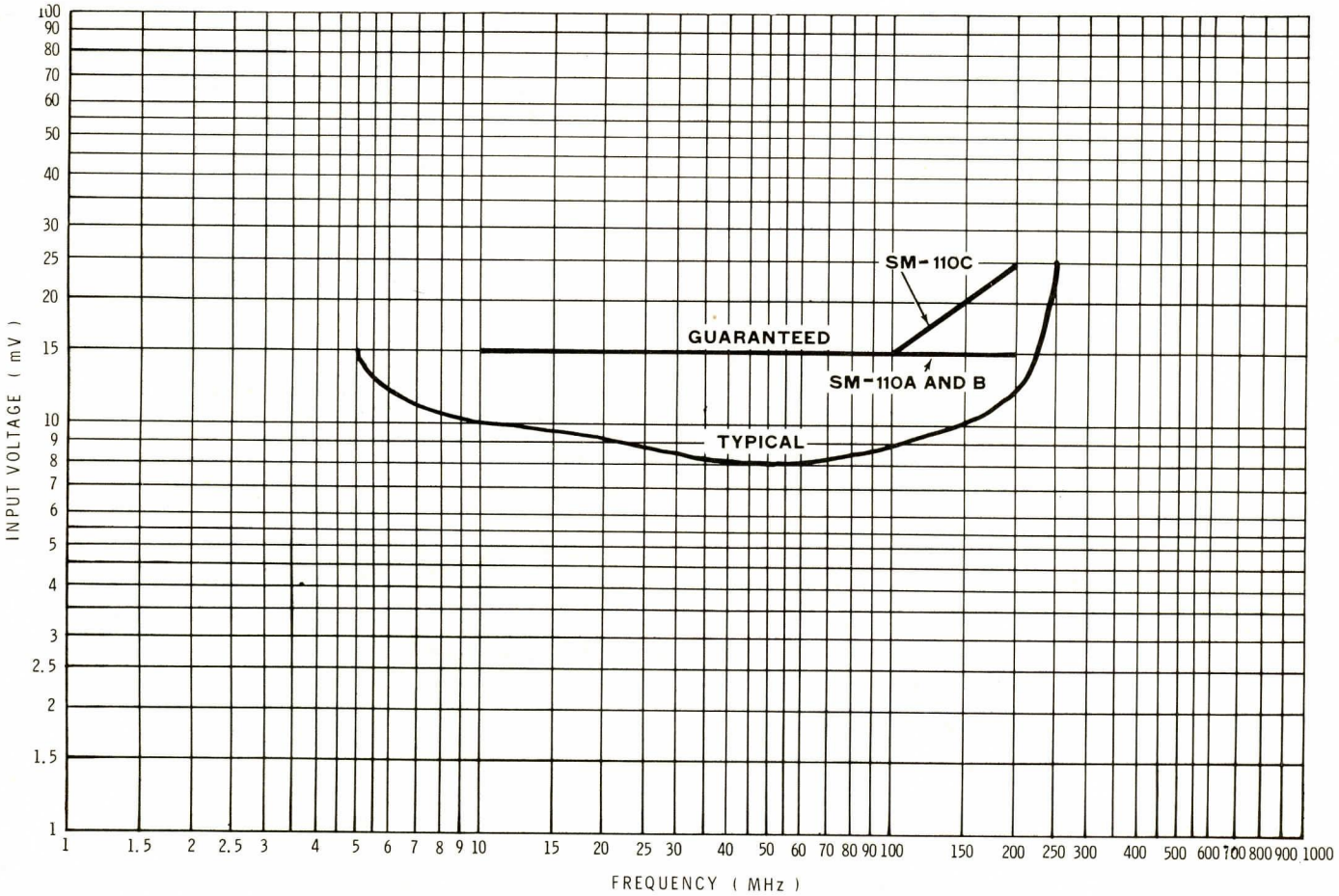


Figure 1-3 B Input frequency response curves showing typical and guaranteed response.

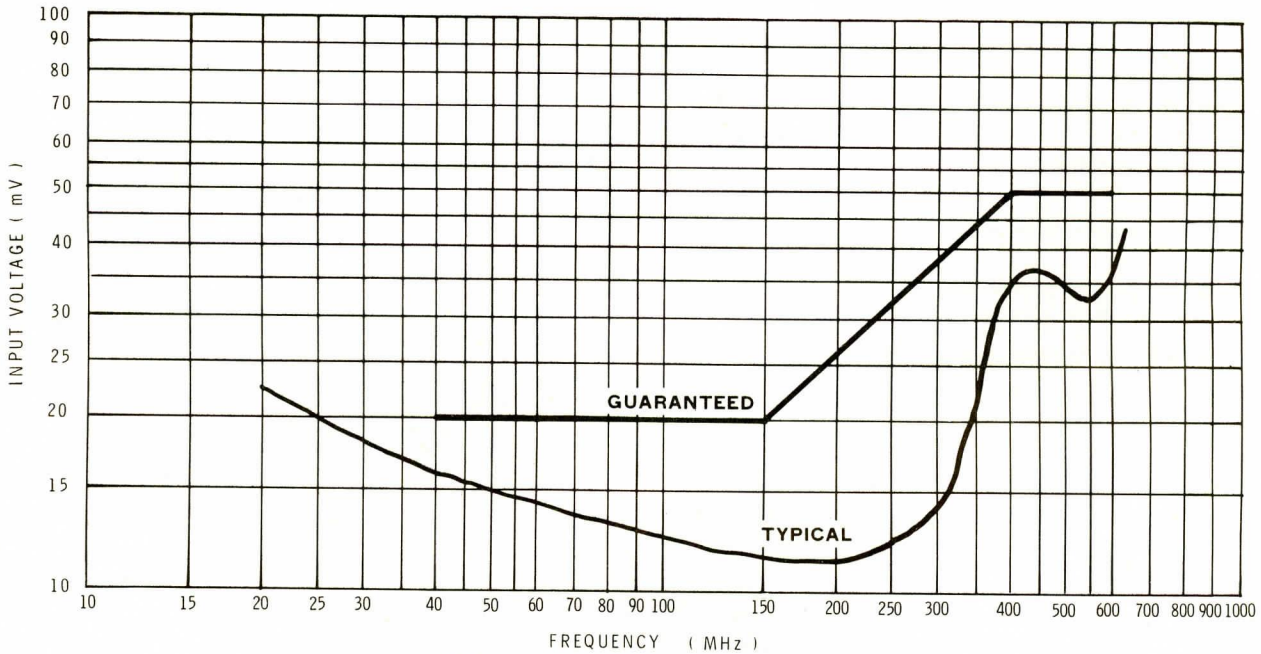


Figure 1-4 B Input Prescale frequency response curves showing typical and guaranteed response.

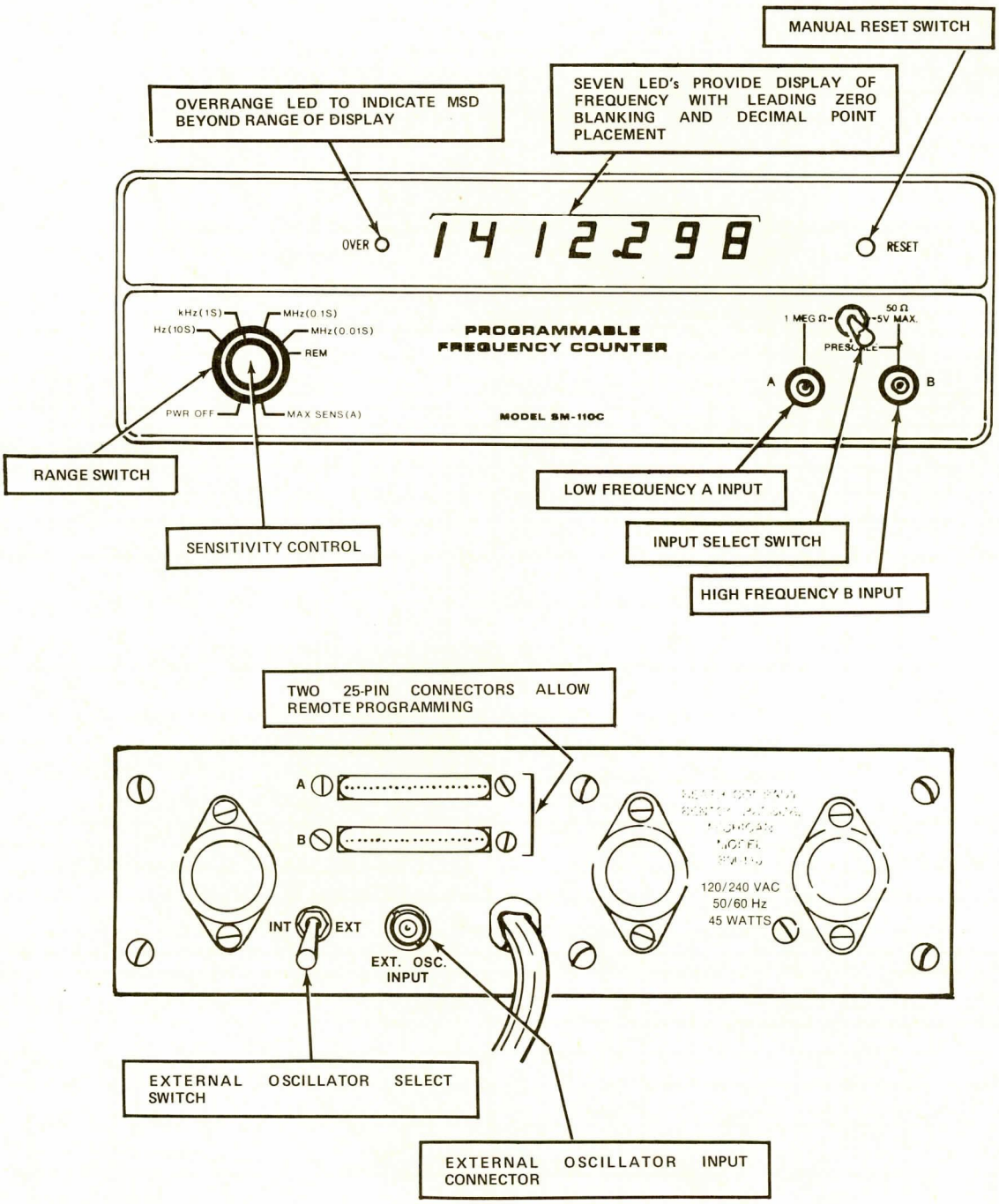


Figure 2-1 Illustrates front and rear panel controls and connectors.

Section 2

OPERATION

Your Counter was carefully checked at the factory prior to shipment and should be ready for operation when it is unpacked and set up. If the shipping carton shows evidence of rough handling, inspect the unit carefully for shipping damage. Report any damage immediately.

CAUTION: Before you proceed with this section, carefully read the Specifications. Damage to the instrument can result if excessive voltage is applied to the input. Input A protection is provided as shown in the Derating Curve of Figure 1-1. Signal level to input B should never exceed 5-volts.

CONTROLS AND CONNECTORS

Figure 2-1 illustrates the front and rear panel controls and connectors. A more detailed description follows.

RANGE SWITCH: Selects four gate interval rates (refer to Table I). NOTE: For external clock frequencies other than 1 MHz, display must be interpreted.

TABLE I

DISPLAY DATA*		
RANGE	GATE INTERVAL	RESOLUTION
Hz	10s	0.1 Hz
kHz	1s	1 Hz
MHz	100 ms	10 Hz
MHz	10 ms	100 Hz

SENSITIVITY CONTROL: Serves as the power switch and allows adjustment of the A input amplifier trigger level above the signal zero-crossing point. Thus, the trigger point can be set above most noise or signal distortion, to insure an accurate count. Its full clockwise position presets the input to its maximum sensitivity level.

OVERRANGE LED: Lights to indicate that the MSD is beyond the range of the display.

RESET SWITCH: When depressed, the Counter resets, the display zeros, and a new count is initiated. NOTE: Continual depression will not hold the instrument in Reset.

INPUT SELECTOR SWITCH: Selects either the A or B input connector. Because of this feature, signals can be applied to both inputs simultaneously without interference. Also selects the prescale circuit through input B on the SM-110C only.

INPUT A: Low frequency, high impedance input jack. [The 1 MΩ impedance allows the use of a standard (÷ 10) 10 MΩ scope probe as a 10 to 1 voltage divider. Frequency response of this input can be limited by the frequency response of the probe.] Signal cables not terminated in their characteristic impedance may cause erratic counting due to reflections.

*With 1 MHz clock.

INPUT B: High frequency, low impedance input jack. The impedance of this input is 50 Ω. On the SM-110C, ultra-high frequencies (up to 600 MHz) can be applied to this jack. Because of the high frequencies involved, only 50 Ω coaxial cable should be used, with as short a length as practical. For frequencies below 10 MHz use Input A.

REMOTE PROGRAMMING CONNECTORS (SM-110B AND C ONLY): Two 25-pin connectors (A and B) allow remote programming of all counter functions when the Range switch is in the REM position (SM-110B and SM-110C only). NOTE: Power OFF and External Oscillator cannot be controlled externally. All display data is present on these connectors regardless of Range switch position.

Refer to Page 2-3 and the fold-out for Tables II and III for Connector Data, Table IV for Range Programming, and Table V for Input Select Programming.

OSCILLATOR (CLOCK) SELECT SWITCH: Selects internal 1 MHz time base clock or externally applied clock signal.

EXTERNAL OSCILLATOR INPUT: Rear panel connector allows application of an external clock signal. Oscillator Select switch must be in the EXT position. Refer to the counter specifications for signal parameters.

210-260 VOLT OPERATION

When shipped, this instrument is ready for operation from a 105-130 volt AC power source. If 210-260 volt AC operation is desired, remove the two screws from the bottom rear of the cabinet shell and pull the cabinet shell off. Place the 120/240 voltage-select switch in the 240 position. Replace the 1/2-ampere fuse with a 1/4-ampere fuse and reinstall the cabinet shell.

NOTE: Electrical regulations in some areas require a special line cord and/or plug for 240-volt operation. Replace if necessary.

OPERATIONAL EXAMPLES

BASIC OPERATION

Connect the signal to be counted and select the input that accommodates the expected frequency range (i.e. Input A 1 Hz to 65 MHz, Input B 10 MHz to 200 MHz, or Input B Prescale 40 MHz to 600 MHz). NOTE: Signals may be connected to both inputs simultaneously; however only the selected input will be counted.

The B input has an input impedance of 50 Ω and will properly terminate 50 Ω transmission line. The A input has a 1 MΩ impedance. Various transmission lines may be used, but these lines should be terminated in their characteristic impedance. If they are not terminated properly, signal reflections can result in a miscount or loss of sensitvity. It may be necessary to adjust the sensitivity level for different signal conditions in the A input channel.

Select the range to give the desired resolution. If the count exceeds the display range, the overrange LED will light. The Counter can be operated in the overranged condition to achieve greater resolution or a shorter gate interval can be selected to display the frequency without overranging.

Example: Input frequency 165.4768932 MHz

RANGE	DISPLAY
MHz	165.4768 MHz
MHz	*65.47689 MHz
kHz	*5476.893 kHz
Hz	*476893.2 Hz

*Indicates Overrange LED illuminated.

It is therefore possible to obtain 0.1 Hz resolution on any count. Given a clock accuracy of ±1 ppm, the accuracy of the above example is ±165.4 Hz.

In measurements where all seven digits of the display are not required, the instrument provides automatic leading zero blanking (nonsignificant leading zeros are blanked).

EXTERNAL CLOCK

In applications where a clock frequency other than 1 MHz or a 1 MHz standard is required, connect the signal to the External Oscillator jack and switch the Oscillator Select to Ext Osc. To prevent reflections, terminate the transmission line. Refer to the Counter Specifications for signal parameters.

With clock frequencies other than 1 MHz, the decimal points and Range switch designations are no longer valid. Each range position will divide the clock frequency by a specified scale factor of 10 (e.g. Hz – 10^7, kHz – 10^6, MHz – 10^5, and MHz – 10^4). This is expressed as:

$$T = \frac{S.F.}{f}$$

where T is Count Time, S.F. is Scale Factor, and f is Clock Frequency.

Example: External clock frequency is 500 kHz.

Range switch position is Hz (10^7).

$$T = \frac{S.F.}{f}$$

$$T = \frac{1 \times 10^7}{5 \times 10^5 \text{ sec}} = 20 \text{ sec}$$

A Frequency Ratio can be determined when the smaller of two frequencies (less than 2 MHz) is applied to the External Oscillator jack and the larger is applied to the appropriate front input. The decimal point and Range switch nomenclature have no relation to the two frequencies.

TABLE I

DISPLAY DATA*		
RANGE	GATE INTERVAL	RESOLUTION
Hz	10s	0.1 Hz
kHz	1s	1 Hz
MHz	100 ms	10 Hz
MHz	10 ms	100 Hz

*With 1 MHz clock.

REMOTE PROGRAMMING

The Remote Programming feature of the SM-110B and SM-110C allows external control of Range, Input Select, Reset, and Count Inhibit. Readout includes 7 digits of BCD (8-4-2-1) display data, decimal points (valid for all ranges), print command, overrange flag, 5-volt reference and circuit ground. Both Remote connectors can remain connected to the counter for normal operation. However, insure that the Inhibit line is low or the counter will not function.

Tables I and II list each pin on the two Remote Connectors and the function it serves. Pins A-14, A-15, and A-16 control Range programming and are logically defined for each range in Table III. Pins A-22 and A-23 are used to select the input. Refer to Table IV for programming data. All control lines require a TTL level high (1) for activation from a remote device or, the 5-volt reference (supplied on the connector) can be used. Each output is a TTL level signal.

TABLE III

REMOTE PROGRAMMING CONNECTOR B			
PIN	FUNCTION	COLOR CODE	TTL FAN OUT
1	BCD 1 Digit 1 (LSD)	BRN	8
2	BCD 2	RED	8
3	BCD 4	YEL	8
4	BCD 8	GRY	8
5	BCD 1 Digit 2	W/BRN	8
6	BCD 2	W/RED	8
7	BCD 4	W/YEL	8
8	BCD 8	W/GRY	8
9	BCD 1 Digit 3	BRN	8
10	BCD 2	RED	8
11	BCD 4	YEL	8
12	BCD 8	GRY	8
13	BCD 1 Digit 4	W/BRN	8
14	BCD 2	W/RED	8
15	BCD 4	W/YEL	8
16	BCD 8	W/GRY	8
17	BCD 1 Digit 5	BRN	8
18	BCD 2	RED	8
19	BCD 4	YEL	8
20	BCD 8	GRY	8
21	BCD 1 Digit 6	W/BRN	8
22	BCD 2	W/RED	8
23	BCD 4	W/YEL	8
24	BCD 8	W/GRY	8
25	GROUND FOR BCD OUTPUT	BLK	8

TABLE II

REMOTE PROGRAMMING CONNECTOR A				
PIN	FUNCTION	COLOR CODE	TTL FAN IN	TTL FAN OUT
1	BCD 1 Digit 7 (MSD)	BRN		8
2	BCD 2	RED		8
3	BCD 4	YEL		8
4	BCD 8	GRY		8
5	NC			
6	NC			
7	NC			
8	NC			
9	Decimal Point 5	WHT		2
10	Decimal Point 4	BLU		2
11	Decimal Point 3	VIOL		2
12	NC			
13	Decimal Point 1	GRN		2
14	Remote Range A	BRN	1	
15	Remote Range B	RED	1	
16	Remote Range C	YEL	1	
17	NC			
18	Reset	BLU	1	
19	Inhibit	GRN	1	
20	Print Command	W/ORG		1
21	Overrange Flag	W/BLK		1
22	A Input Select	W/GRN	1	
23	B Input Select	W/BLU	1	
24	5-Volt Reference	RED	390 Ω series resistor	
25	Circuit Ground	BLK	NA	

TABLE IV

REMOTE RANGE PROGRAMMING				
DATA LINE			COUNT TIME	RANGE
A	B	C		
0	0	0	10 s	Hz
1	0	0	1 s	kHz
0	1	0	100 ms	MHz
1	1	0	10 ms	MHz
0	0	1	1 ms	MHz
1	0	1	100 μs	GHz*
0	1	1	10 μs	GHz*
1	1	1	1 μs	GHz*

*No front panel GHz indicator.

TABLE V

REMOTE INPUT SELECT		
DATA LINE		INPUT SELECTED
A	B	
1	0	A
0	1	B
0	0	PRESCALE
1	1	NA

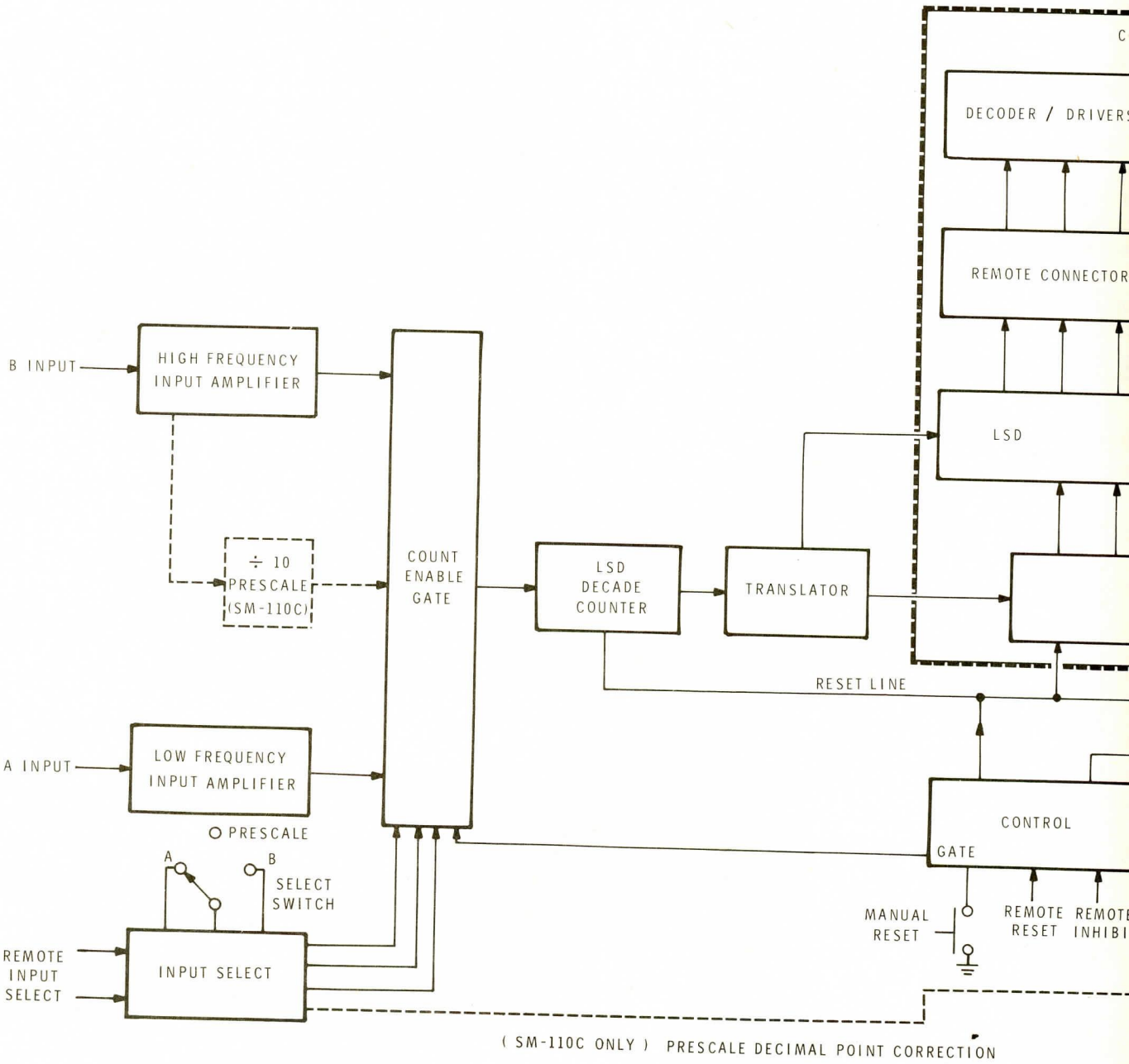
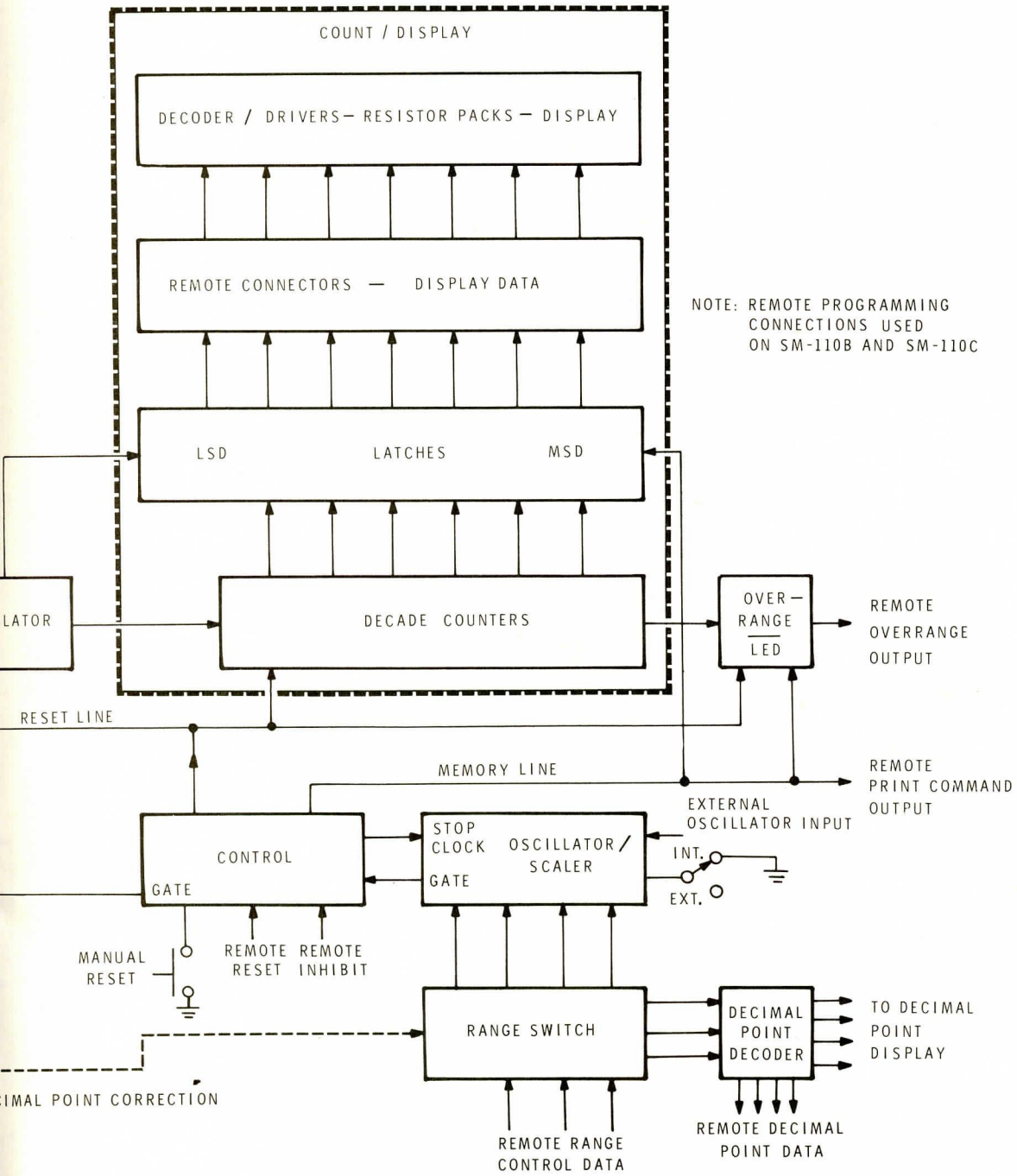


Figure 3-1 Block Diagram of SM-110 Series Frequency Counters.



-1 Block Diagram of Series Frequency Counters.

Section 3

CIRCUIT DESCRIPTION

The SM-110 Series of Frequency Counters consists of two input sections, a 1 MHz clock and scaler, gating and control circuits, count and display circuits, overrange detector, and power supply. Refer to Figure 3-1 (fold-out from Page 2-4) and the Schematic (fold-out from Page 5-5 or 5-7) for interrelation of these circuits as discussed in the paragraphs that follow.

INPUTS

Two separate inputs are provided to accommodate signal parameters encountered at various frequencies. The Low Frequency Input Amplifier (A) consists of a protected, high impedance FET/Bipolar pair and a three-stage IC amplifier. Input level at the amplifier is set by the ganged Sensitivity controls. The last stage also serves as a Schmitt Trigger to properly shape low frequency signals for counting. The second input is a 50 ohm wide band amplifier module with internal input protection. Both input amplifiers are coupled to the Count Enable Gate. In addition to the two input amplifiers, the SM-110C contains an ultra-high frequency Decade Prescaler whose output is also coupled to the Count Enable Gate.

CONTROL

The 1 MHz Oscillator/Scaler is a precise time base that controls all of the gating and timing circuits and determines the accuracy of the instrument. The clock used on the SM-110B and C is a temperature-compensated 1 MHz crystal oscillator (TCXO). To obtain the desired gate time, the 1 MHz signal is divided by the selected number of decades, as determined by the Range switch. A single MOS LSI IC performs the scaling function and is directly controlled by the Range switch. In addition, the Range switch provides three lines of data to the Decimal Point Decoder. The selected gate signal is coupled to the Control section where it is conditioned before application to the Count Enable Gate. The Control section also properly sequences the gate, memory pulses, and reset. Manual Reset triggers a monostable which resets the Display and initiates a new gate cycle.

The Input Select determines the input signal to be coupled through the Count Enable Gate. This is controlled by the front panel Select switch or remote program data lines (on the SM-110B and C).

DISPLAY

The gated input signal is coupled into the LSD Decade Counter where the number of pulses per unit time are counted. The pulse information is then fed through the Translator for conversion from ECL logic to TTL logic levels. From the Translator the pulse information is transferred to the LSD Latch and the remaining Decade Counters where it is counted, stored (Latches), decoded (Decoder/Drivers), and displayed (LED's).

If the count per unit time exceeds the capacity of the Display, the spill-over from the MSD will trigger the Overrange circuit and turn on the LED. In the SM-110B and C, the overrange data is available at the Remote Programming Connector.

Decimal point position is controlled by the Range Switch circuit. Three lines of data are translated by the Decimal Point Decoder into four control lines. The signal on these lines turn on the proper decimal point and control the Decoder/Drivers for leading-zero blanking. On the SM-110B and C models, these four data lines provide external decimal point information.

POWER SUPPLY

The Power Supply operates with either 120-volts AC or 240-volts AC, 50/60 Hz. It supplies the proper voltage levels to operate all circuitry. These required voltages are −12 volts DC, +5 volts DC, and +19 volts DC. In the SM-110B and C, an additional +15 volts DC is supplied for the TCXO.

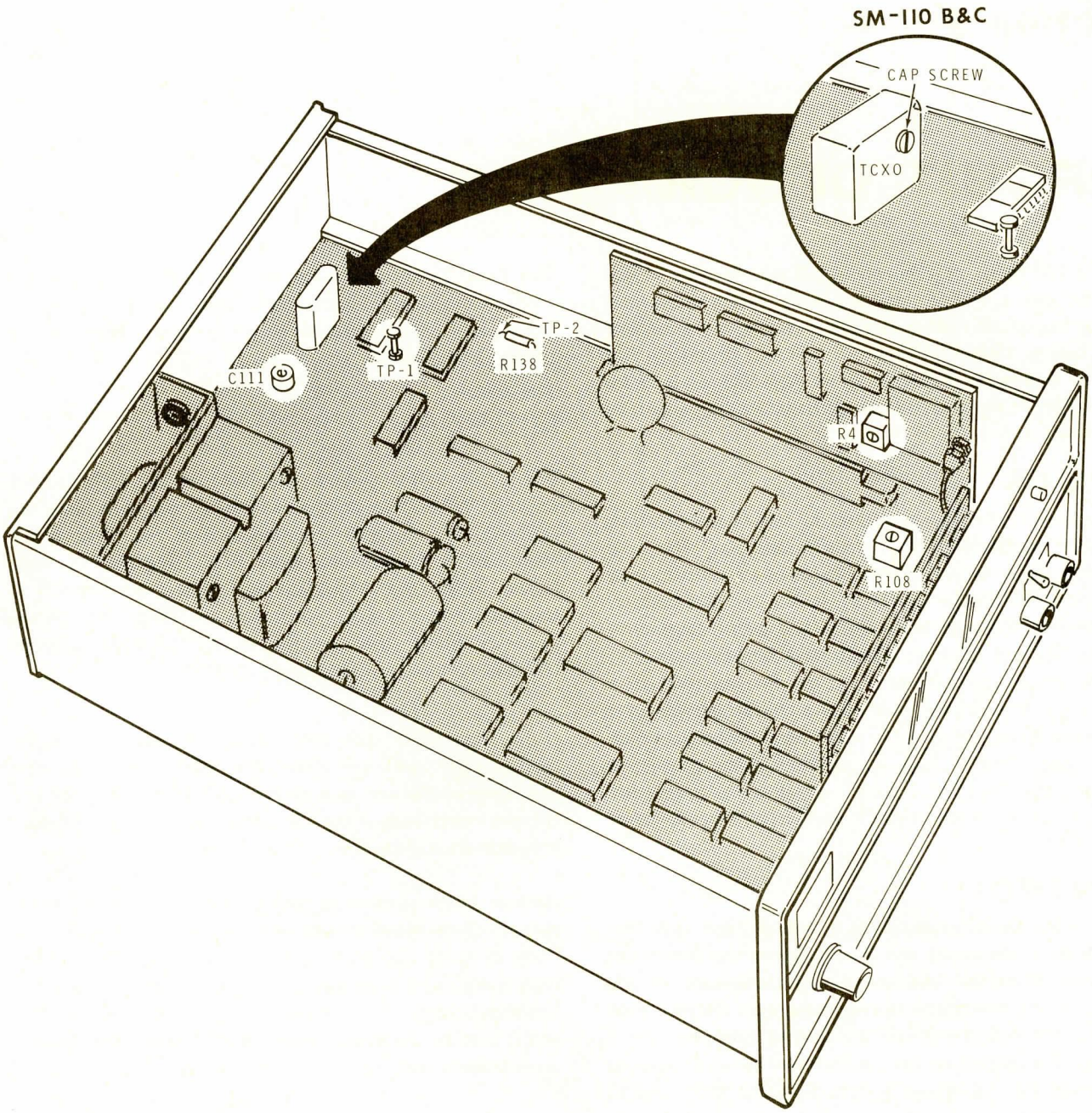


Figure 4-1 Location of the test point and adjustments for instrument calibration.

Section 4

RECALIBRATION

Calibration of this instrument should not be attempted unless you are experienced and qualified in the use of precision laboratory equipment. If difficulty occurs during repair or calibration, refer to the inside rear cover of this manual for information on technical assistance. Figure 4-1 shows the location of the adjustments and test points. Basically, Clock Calibration and Input Amplifier Adjustment are identical for each model counter.

CLOCK CALIBRATION

The following adjustments should not be attempted unless you have extremely accurate test equipment. We strongly recommend that you return the Counter to your supplier if you are certain that calibration is necessary.

To calibrate the oscillator, you will need an oscilloscope with an Input sensitivity of at least 5 mV/division and a Time Base capability to at least 0.2 μs/division and a 1 MHz frequency standard with accuracy at least an order of magnitude better than desired for the counter. Allow the counter and test instrument to thoroughly warm up. Test Points 1 and 2 are not used for clock calibration. They are provided for initial instrument check-out and troubleshooting only.

Connect the 1 MHz standard to the Trigger Input of the Oscilloscope and connect the Vertical Input of the Oscilloscope to the External Oscillator connector on the rear panel of the counter. Set the Counter Range switch to the high MHz position and the Oscilloscope Time Base to 0.2 μs. On the SM-110A, adjust the trimmer capacitor C17 for a stable trace (trace drift rate is slower than two seconds per division) on the Oscilloscope. For the SM-110B and SM-110C, remove the screw from the side of the TCXO and insert a nonmetallic alignment tool. Adjust for a stable trace. After each adjustment, allow the crystal to stabilize for about 15 minutes. Reinstall the TCXO cap screw. DO NOT OVERTIGHTEN.

INPUT AMPLIFIER ADJUSTMENTS

A generator capable of 200 MHz with an output of at least 700 mV is required for the input amplifier adjustments. Allow the generator and counter sufficient time to warm up.

B INPUT ADJUSTMENT

Connect the generator to the B input of the counter and adjust the generator for 200 MHz at 700 mV. Adjust R4 to produce a stable count. Reduce the generator input level and adjust R4 for a stable count. Continue to reduce the input level until R4 will no longer stabilize the display. This is the optimum setting for input B. NOTE: The Prescale input (SM-110C) does not require adjustment.

A INPUT ADJUSTMENT

Connect the generator to the A input of the counter and adjust the generator for 50 MHz at approximately 700 mV. Make sure the Sensitivity control is in its MAX position (full clockwise rotation). Adjust control R108 to produce a stable display. Reduce the generator input level and adjust R108 for a stable count. Continue to reduce the input level until R108 will no longer stabilize the display. This is the optimum setting for input A.

The counter is now completely calibrated. Reinstall the cover.

Section 5

APPENDIX

This section of the manual contains Parts Lists, Integrated Circuit Base Diagrams, Circuit Board X-Ray Views, and Schematic Diagrams. A separate Schematic is provided for the SM-110A, and another for the SM-110B and SM-110C.

PARTS LIST

Component values and key numbers relate to the Schematic, X-Ray Views, and associated figures. Information on parts availability and prices will be sent on request.

FRONT END CIRCUIT BOARD

RESISTORS-CONTROLS

(All resistors are 1/8-watt, 5%, unless otherwise specified.)

KEY No.	PART No.	DESCRIPTION
R1	1-145	47 Ω, 1/2-watt
R2	1-6-11	270 Ω (A and B only)*
R3	1-18-11	180 Ω
R4	10-940	200 Ω, 1/2-watt, linear control
R5	1-21-11	100 Ω
R6	1-10-11	1000 Ω
R7	1-7-11	10 kΩ (C only)*
R8	1-6-11	270 Ω
R9	1-6-11	270 Ω
R10	1-125-12	22 Ω (C only)*
R11	1-19-11	470 Ω
R12	1-19-11	470 Ω
R13	1-6-11	270 Ω
R14	1-7-11	10 kΩ (B and C only)*
R15	1-19-11	470 Ω (C only)*
R16	1-10-11	1000 Ω (C only)*
R17	1-6-11	270 Ω
R18	1-21-11	100 Ω
R19	1-6-11	270 Ω
R20	NOT USED	
R21	1-21-11	100 Ω
R22	1-10-11	1000 Ω
R23	1-2-11	220 Ω
R24	1-23-11	68 Ω
R25	1-23-11	68 Ω
R26	1-6-11	270 Ω
R27	1-6-11	270 Ω
R28	1-23-11	68 Ω
R29	1-2-11	220 Ω
R30	NOT USED	
R31	1-23-11	68 Ω
R32	1-10-11	1000 Ω
R33	1-18-11	180 Ω
R34	1-17-11	82 Ω
R35	1-6-11	270 Ω
R36	1-24-11	330 Ω
R37	1-24-11	330 Ω
R38	1-25-11	820 Ω
R39	1-25-11	820 Ω

*(A) used in SM-110A
*(B) used in SM-110B
*(C) used in SM-110C

KEY No.	PART No.	DESCRIPTION
CAPACITORS-FERRITE BEAD		
C1	25-248	100 μF, electrolytic
C2	21-185	0.01 μF, ceramic (C only)*
C3	21-51	20 pF, ceramic (A and B only)*
C4	21-185	0.01 μF, ceramic (C only)*
C5	21-185	0.01 μF, ceramic (C only)*
C6	21-185	0.01 μF, ceramic (C only)*
C7	25-220	10 μF, tantalum
C8	25-220	10 μF, tantalum
C9	21-33	3.3 pF, ceramic (C only)*
L1	40-1664	5-turn coil (C only)*
DIODES-TRANSISTORS-INTEGRATED CIRCUITS		
D1	56-56	1N4149
D2	56-56	1N4149
D3	56-56	1N4149
D4	56-56	1N4149 (B and C only)*
D5	56-607	1N82AG (C only)*
D6	56-607	1N82AG (C only)*
Q1	417-201	X29A829
Q2	417-201	X29A829
Q3	417-118	2N3393
Q4	417-292	2N5771
Q5	417-292	2N5771
Q6	417-292	2N5771
Q7	417-292	2N5771
Q8	417-118	2N3393
Q9	417-170	MPS6522
IC-1	150-34	Wideband hybrid amplifier (A and B only)*
IC-1	150-44	Wideband hybrid amplifier (C only)*
IC-2	443-95	600 MHz, Decade Driver (C only)*
IC-3	443-79	ECL 95H03, triple OR/NOR gate
IC-4	443-613	ECL 95H28, dual D flip-flop selected
IC-5	443-83	ECL 95H28, dual D flip-flop
IC-6	443-79	ECL 95H03, triple OR/NOR gate
IC-7	443-82	ECL 9528, dual D flip-flop
IC-8	443-54	7403, quad NAND gate
CONNECTORS		
	432-121	Male circuit board pin
	432-764	Female coax receptacle

DISPLAY CIRCUIT BOARD

KEY No.	PART No.	DESCRIPTION
Connectors (cont'd.)		
LED-1-7	412-77	Seven-segment LED
LED-8	412-70	Single-segment LED
	434-240	14-pin IC socket

MAIN CIRCUIT BOARD

RESISTORS-CONTROLS

(All resistors are 1/4-watt, 5% unless otherwise specified.)

R101	1-87-12	1 MΩ
R102	1-87-12	1 MΩ
R103	1-63-12	270 Ω
R104	1-67-12	680 Ω
R105	1-63-12	270 Ω
R106	1-64-12	390 Ω
R107	1-74-12	3300 Ω
R108	10-940	200 Ω, 1/2-watt, linear control
R109	1-65-12	470 Ω
R110	NOT USED	
R111		1500 Ω – 1500 Ω dual control part of Range switch
R112	1-60-12	100 Ω
R113	1-74-12	3300 Ω
R114	1-63-12	270 Ω
R115	1-63-12	270 Ω
R116	1-63-12	270 Ω
R117	1-61-12	180 Ω
R118	1-80-12	10 kΩ
R119	1-80-12	10 kΩ
R120	NOT USED	
R121	1-80-12	10 kΩ
R122	1-61-12	180 Ω
R123	1-61-12	180 Ω
R124	1-61-12	180 Ω
R125	1-61-12	180 Ω
R126	1-61-12	180 Ω
R127	1-69-12	1000 Ω
R128	1-69-12	1000 Ω (B and C only)*
R129	1-80-12	10 kΩ (B and C only)*
R130	NOT USED	
R131	1-79-12	8200 Ω

KEY No.	PART No.	DESCRIPTION
Resistors-Controls (cont'd.)		
R132	1-79-12	8200 Ω
R133	1-69-12	1000 Ω
R134	1-79-12	8200 Ω
R135	1-79-12	8200 Ω
R136	1-65-12	470 Ω
R137	1-65-12	470 Ω
R138	1-69-12	1000 Ω
R139	1-10-12	15 kΩ
R140	1-80-12	10 kΩ
R141	1-87-12	1 MΩ (A only)*
R142	1-111-12	1.5 MΩ (A only)*
R142	1-69-12	1000 Ω (B and C only)*
R143	1-63-12	270 Ω
R144	1-69-12	1000 Ω
R145	1-69-12	1000 Ω
R146	1-69-12	1000 Ω
R147	1-64-12	390 Ω (B and C only)*
R148	1-69-12	1000 Ω (B and C only)*
R149	1-157	470 Ω, 1/2-watt
R150	NOT USED	
RESISTOR PACKS		
RP-101	9-53	180 Ω, 10%, resistor pack
RP-102	9-53	180 Ω, 10%, resistor pack
RP-103	9-53	180 Ω, 10%, resistor pack
RP-104	9-53	180 Ω, 10%, resistor pack
RP-105	9-53	180 Ω, 10%, resistor pack
RP-106	9-53	180 Ω, 10%, resistor pack
RP-107	9-53	180 Ω, 10%, resistor pack
CAPACITORS-CRYSTALS		
C101	21-3	10 pF, ceramic
C102	NOT USED	
C103	25-223	47 μF, tantalum
C104	21-192	0.1 μF, ceramic
C105	25-277	100 μF, tantalum
C106	25-220	10 μF, tantalum
C107	20-107	680 pF, mica
C108	25-277	100 μF, tantalum
C109	21-100	0.47 μF, ceramic
C110	NOT USED	
C111	31-57	2-20 pF ceramic trimmer (A only)*
C112	21-181	7.7 pF, mica (A only)*
C113	20-160	33 pF, mica (A only)*

KEY No.	PART No.	DESCRIPTION
Capacitors-Crystals (cont'd.)		
C114	25-223	47 μF, tantalum
C115	21-99	0.2 μF, ceramic
C116	25-272	6000 μF, electrolytic
C117	25-220	10 μF, tantalum
C118	25-220	10 μF, tantalum
C119	25-220	10 μF, tantalum
C120	NOT USED	
C121	21-99	0.2 μF, ceramic
C122	25-220	10 μF, tantalum
C123	25-220	10 μF, tantalum
C124	25-220	10 μF, tantalum
C125	21-99	0.2 μF, ceramic
C126	25-199	500 μF, electrolytic
C127	25-220	10 μF, tantalum (B and C only)*
C128	25-220	10 μF, tantalum
C129	25-121	500 μF, electrolytic
C130	NOT USED	
C131	21-42	.01 μF, 1.6 kV, ceramic
Y1	404-424	1 MHz crystal (A only)*
TCXO	150-27	1 MHz temperature-compensated crystal oscillator (B and C)*
DIODES-TRANSISTORS		
D101	56-86	FD777
D102	56-86	FD777
D103	56-61	GESTB, stabistor
D104	56-56	1N4149
D105	56-56	1N4149
D106	56-59	1N750A, 4.7-volt zener
D107	57-71	5-ampere silicon rectifier
D108	57-71	5-ampere silicon rectifier
D109	57-65	1N4002
D110	56-67	VR-10A 10-volt zener
D111	57-65	1N4002
D112	56-36	VR-16.1G, 16.1-volt zener (B and C only)*
D113	57-65	1N4002
D114	56-57	1N716, 12-volt zener
Q101	417-288	2N4416, JFET selected
Q102	417-170	MPS6522
Q103	417-118	2N3393
Q104	417-118	2N3393
Q105	417-118	2N3393
Q106	417-154	2N2369
Q107	417-154	2N2369
Q108	417-154	2N2369
Q109	417-118	2N3393
Q110	NOT USED	
Q111	417-110	S2090 (C only)*

KEY No.	PART No.	DESCRIPTION

INTEGRATED CIRCUITS

IC-101	443-98	ECL 9582, triple line receiver
IC-102	443-13	7475 quad D-type latch
IC-103	443-36	7447, 7-segment decoder driver
IC-104	443-628	N8290A, decade counter
IC-105	443-37	74100, 8-bit bi-stable latch
IC-106	443-36	7447, 7-segment decoder driver
IC-107	443-7	7490, decade counter
IC-108	443-36	7447, 7-segment decoder driver
IC-109	443-7	7490, decade counter
IC-110	NOT USED	
IC-111	443-37	74100, 8-bit bi-stable latch
IC-112	443-36	7447, 7-segment decoder driver
IC-113	443-7	7490, decade counter
IC-114	443-36	7447, 7-segment decoder driver
IC-115	443-7	7490, decade counter
IC-116	443-37	74100, 8-bit bi-stable latch
IC-117	443-36	7447, 7-segment decoder driver
IC-118	443-7	7490, decade counter
IC-119	443-36	7447, 7-segment decoder driver
IC-120	NOT USED	
IC-121	443-1	7400, quad NAND gate
IC-122	443-4	7472, J-K master slave flip-flop
IC-123	443-87	74145 BCD-decimal decoder driver
IC-124	443-90	74123, dual monostable
IC-125	443-90	74123, dual monostable
IC-126	443-45	7408, quad AND gate
IC-127	443-54	7403, quad open-collector NAND gate

KEY No.	PART No.	DESCRIPTION

Integrated Circuits (cont'd.)

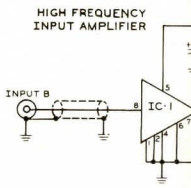
IC-128	443-84	MK5009P, oscillator – scaler – multiplexer
IC-129	443-94	7483, 4-bit full adder (C only)*
IC-130	NOT USED	

GENERAL PARTS

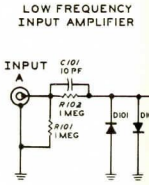
S5	60-68	Slide switch – line voltage
	432-121	Male circuit board pin
	432-757	Female 56-connector strip
	262-8	Test point connector pin
	260-65	Fuse clip
	421-20	1/2-ampere fuse

CHASSIS COMPONENTS

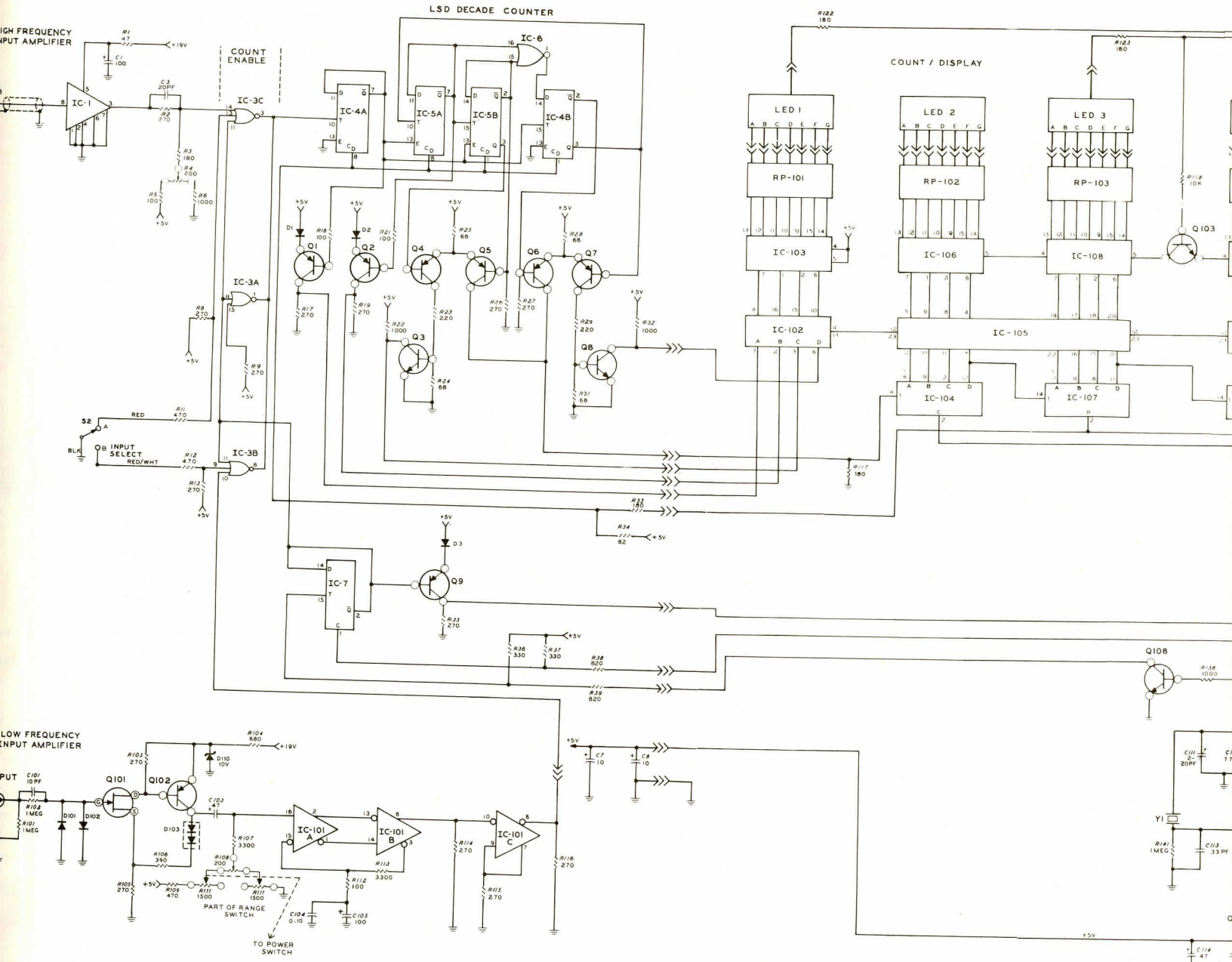
S1	63-704	Rotary Range switch (A only)*
S1	63-705	Rotary Range switch (B and C only)*
S2	61-16	2-position Input Select toggle switch (A and B)*
S2	61-19	3-position Input Select toggle switch (C only)*
S3	61-16	2-position External Oscillator toggle switch
S4	64-31	Reset pushbutton
IC-201	442-30	309, 5-volt regulator
IC-202	442-30	309, 5-volt regulator
IC-203	442-30	309, 5-volt regulator
T1	54-811	Power transformer
	89-22	Line cord
	75-182	Line cord strain relief
	434-117	Regulator socket
	432-120	Female connector (mate to 432-121)
	432-758	BNC connector
	432-59	Short BNC connector
	432-763	Male coax connector (mate to 432-764)

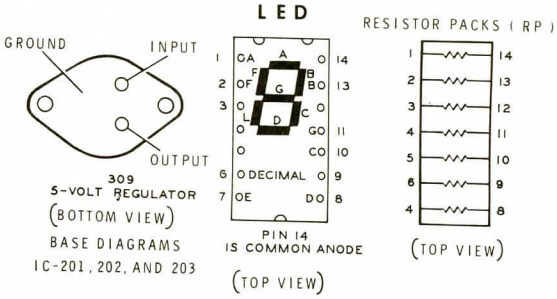

HIGH FREQUENCY
INPUT AMPLIFIER
INPUT B
IC-1

S2
BLK


LOW FREQUENCY
INPUT AMPLIFIER
INPUT
C101
10 PF
R102
1 MEG
R101
1 MEG
D101

GROUN

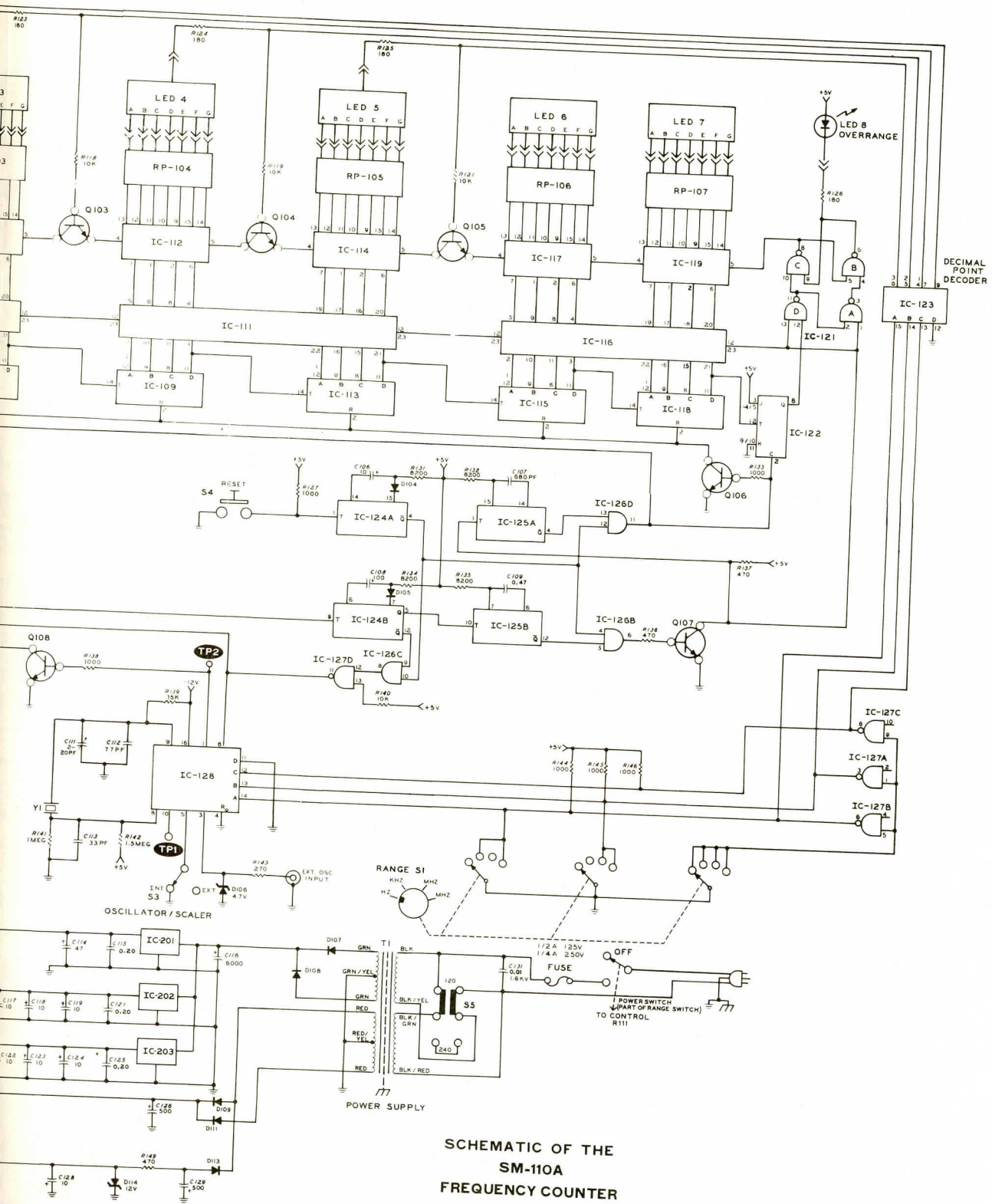




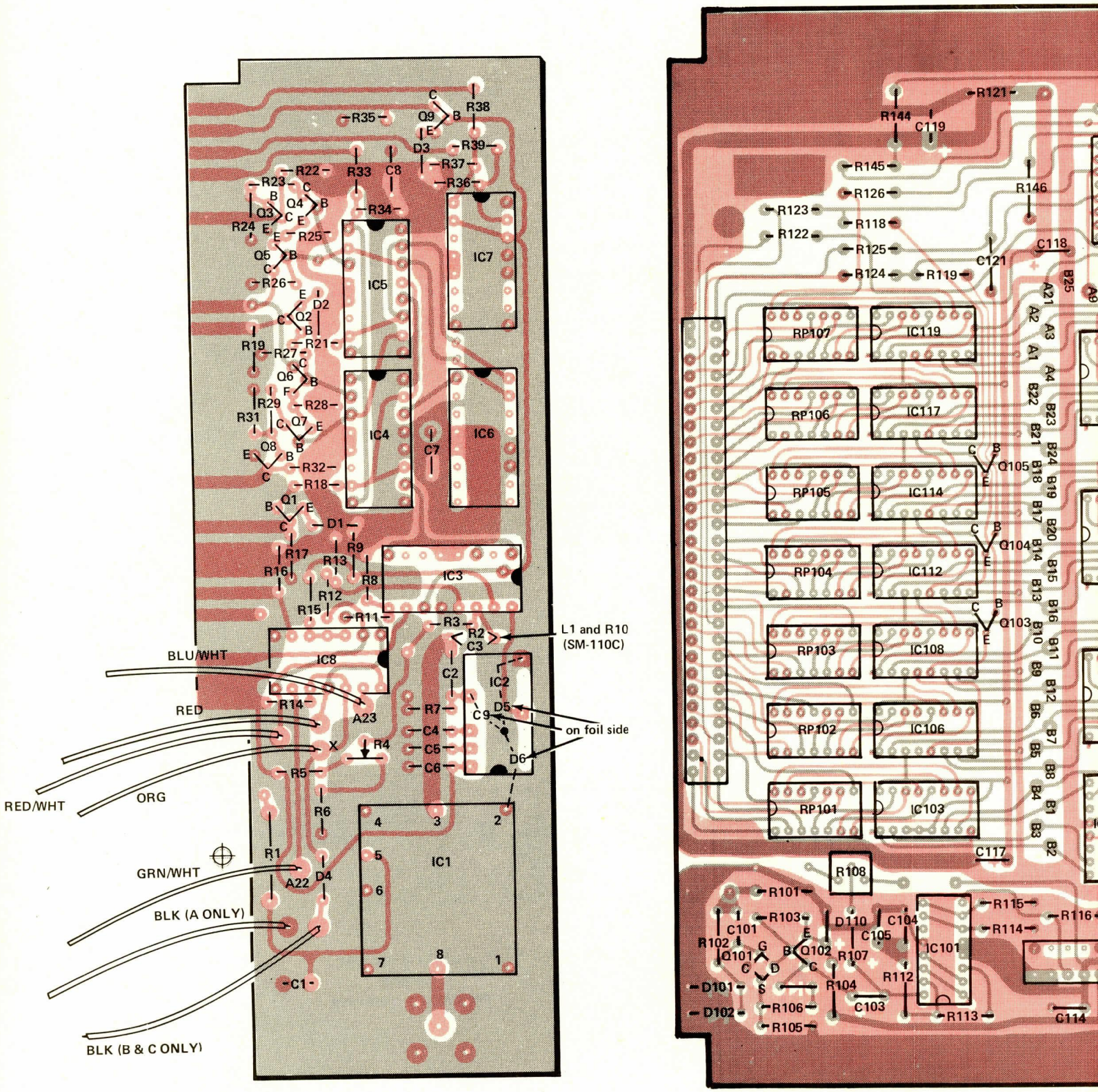
BASE DIAGRAMS
IC-201, 202, AND 203

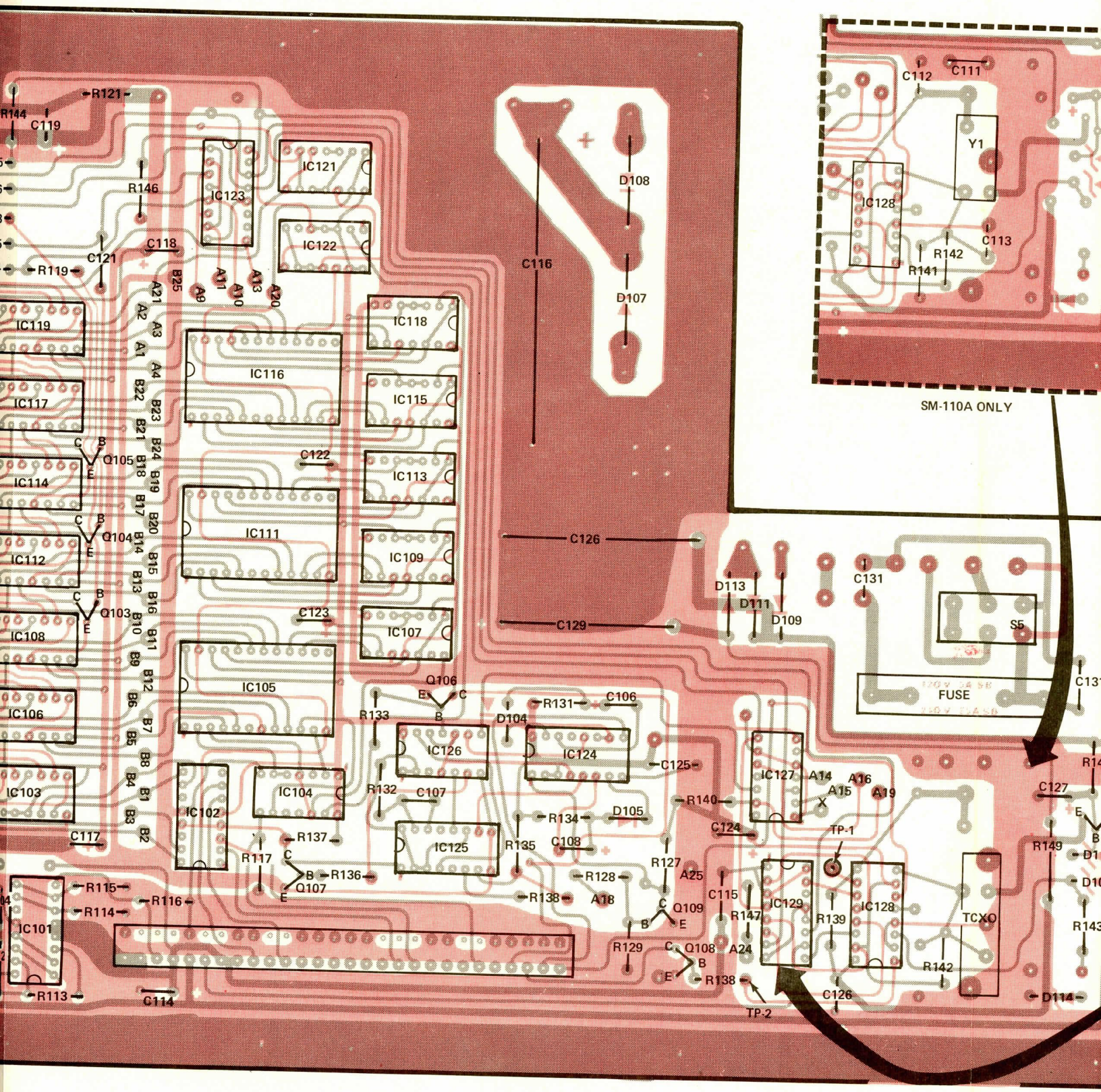
SCHEMATIC NOTES:

1. ALL RESISTOR VALUES ARE IN OHMS UNLESS OTHERWISE INDICATED.
2. ALL CAPACITOR VALUES ARE IN MICROFARADS (ufd) UNLESS OTHERWISE INDICATED.
3. >> INDICATES CONNECTOR TO DISPLAY BOARD.
4. >>> INDICATES CONNECTOR TO FRONT END BOARD



SCHEMATIC OF THE
SM-110A
FREQUENCY COUNTER

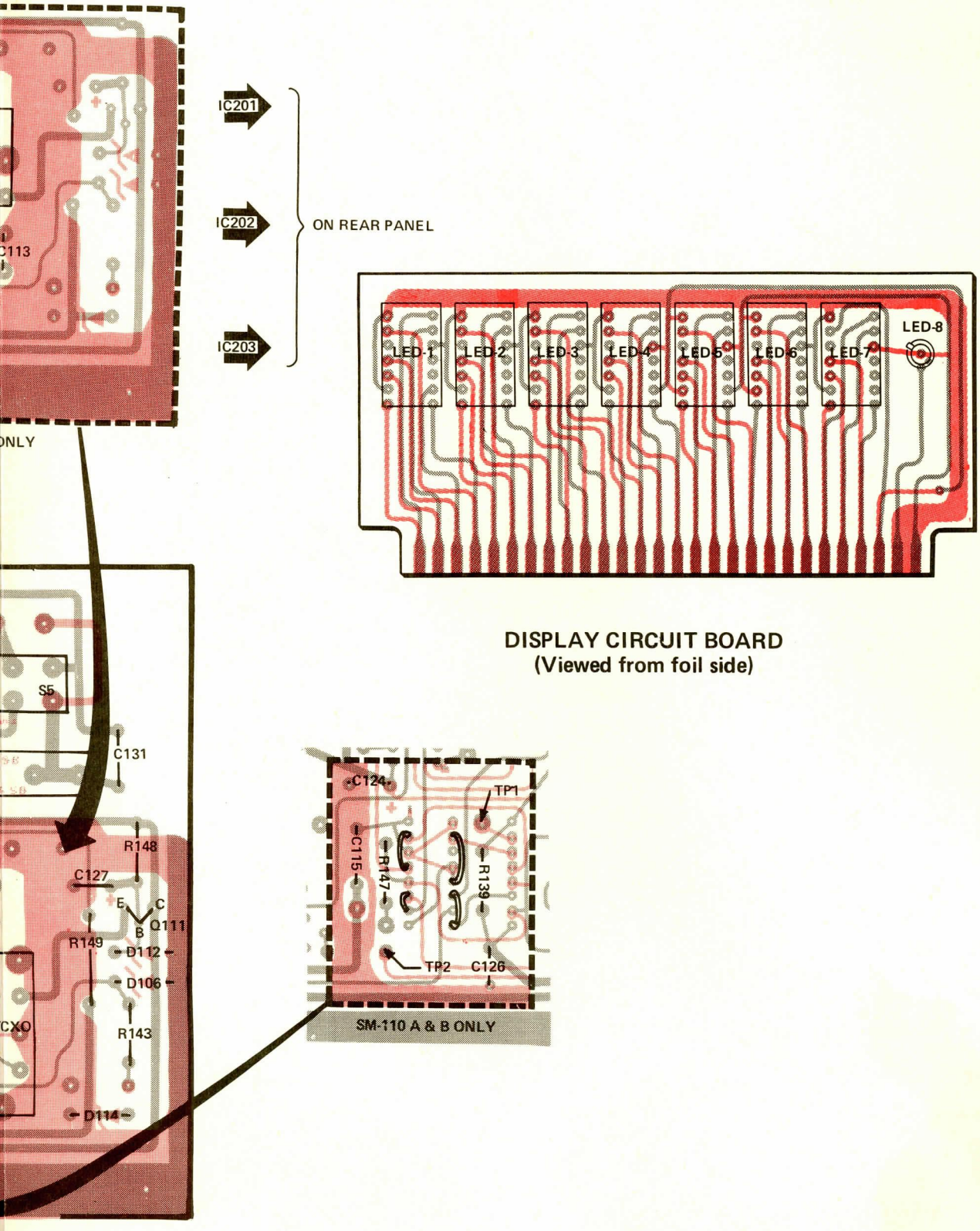

R35
Q9
R38
D3
R39
R37
R36
R22
R33
C8
R23
Q4
Q3
R24
R34
R25
Q5
R26
IC5
IC7
D2
Q2
R21
R19
R27
Q6
R29
R28
R31
Q7
Q8
R32
IC4
IC6
C7
R18
Q1
D1
R17
R9
R13
R16
R8
IC3
R12
R15
R11
R3
R2
C3
L1 and R10
(SM-110C)
BLU/WHT
IC8
C2
IC2
R14
A23
R7
C9
D5
on foil side
RED
C4
X
R4
C5
D6
R5
C6
RED/WHT
ORG
R6
4
3
2
R1
5
IC1
GRN/WHT
A22
D4
6
BLK (A ONLY)
7
8
1
C1
BLK (B & C ONLY)
R121
R144
C119
R145
R146
R126
R123
R118
R122
R125
C118
C121
R124
R119
RP107
IC119
RP106
IC117
Q105
RP105
IC114
Q104
RP104
IC112
Q103
RP103
IC108
RP102
IC106
RP101
IC103
C117
R108
R101
R115
R116
R103
C101
D110
C104
R114
R102
C105
Q101
Q102
R107
IC101
R112
D101
R104
C103
D102
R106
R113
C114
R105



MAIN CIRCUIT BOARD
(Viewed from component side)

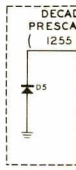
X-RAY VIEWS

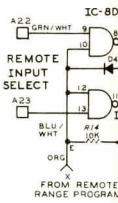
(WIRE HARNESS NUMBERS REFER TO SM-110B & C)



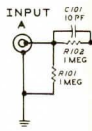
DISPLAY CIRCUIT BOARD
(Viewed from foil side)

HIGH FREQUENC
INPUT AMPLIFIE

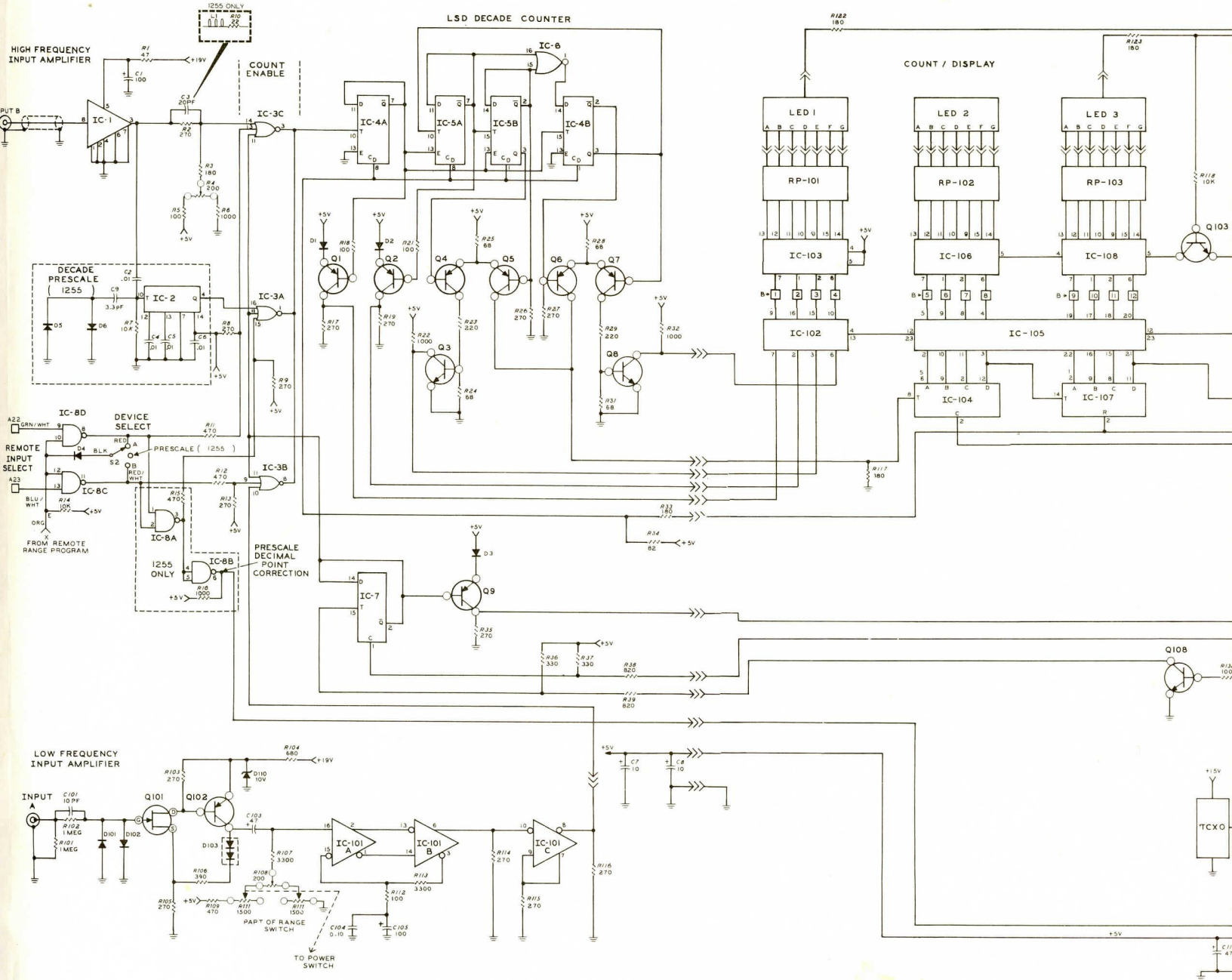




LOW FREQ
INPUT AMP



5-
(B
BA
IC-2



309
5-VOLT REGULATOR
(BOTTOM VIEW)
BASE DIAGRAMS
IC-201, 202, AND 203

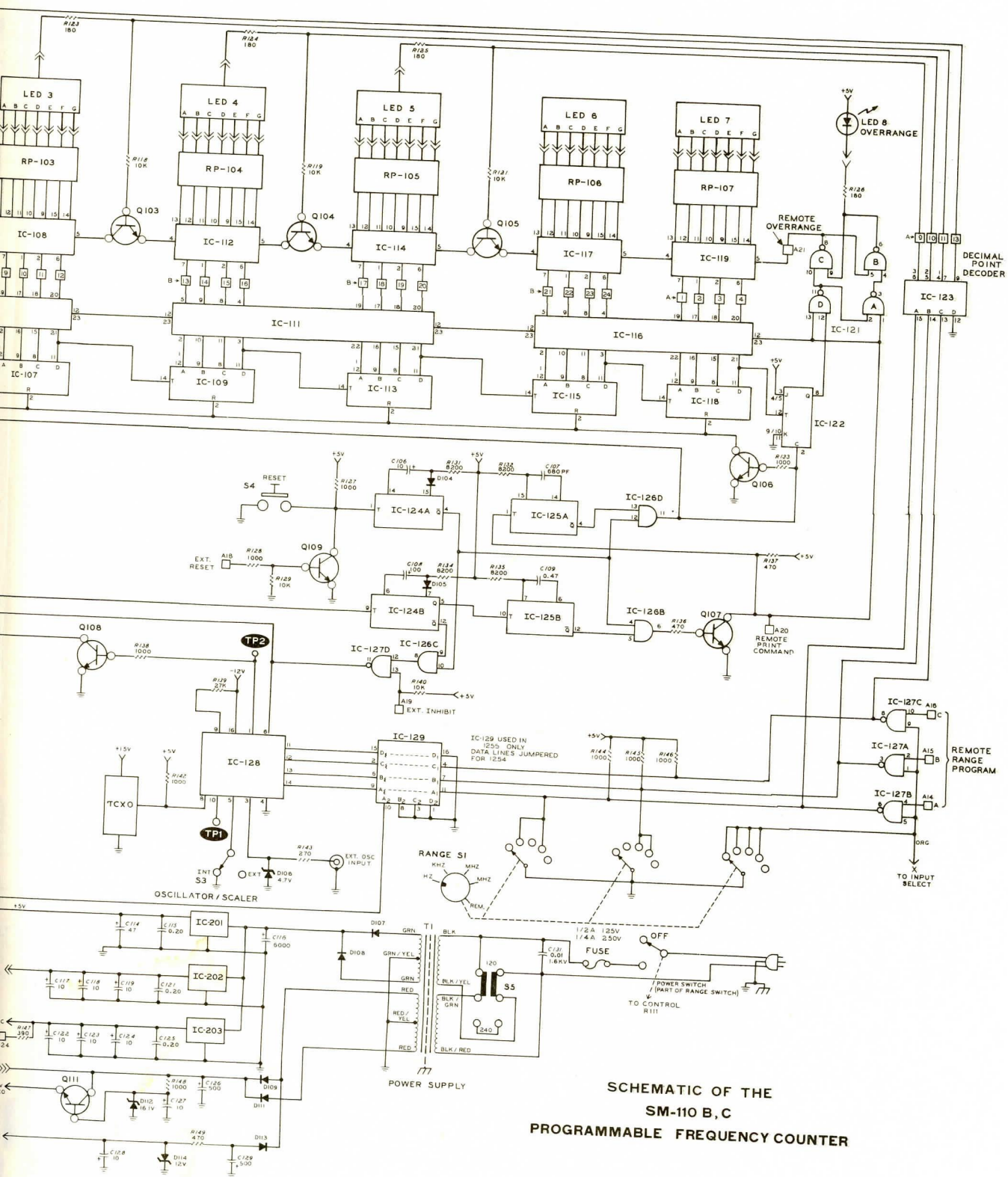
GROUND
INPUT
OUTPUT

LED
PIN 14
IS COMMON ANODE
(TOP VIEW)

RESISTOR PACKS (RP)
(TOP VIEW)

SCHEMATIC NOTES:

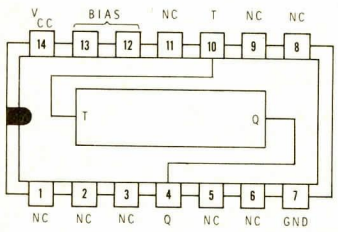
1. ALL RESISTOR VALUES ARE IN OHMS UNLESS OTHERWISE INDICATED.
2. ALL CAPACITOR VALUES ARE IN MICROFARADS (ufd) UNLESS OTHERWISE INDICATED.
3. >> INDICATES CONNECTOR TO DISPLAY BOARD.
4. >>> INDICATES CONNECTOR TO FRONT END BOARD
5. □ INDICATES REMOTE CONNECTOR PIN.



SCHEMATIC OF THE
SM-110 B, C
PROGRAMMABLE FREQUENCY COUNTER

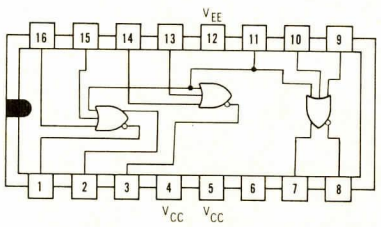
INTEGRATED CIRCUIT BASE D
(TOP VIEW)

IC-2



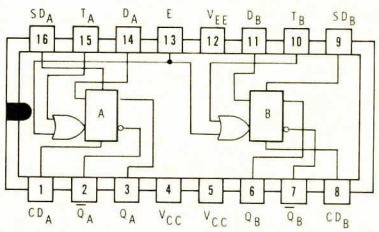
600 MHz ÷ 10

IC—3,6



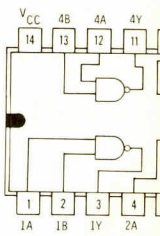
ECL 95H03
TRIPLE OR/NOR GATES

IC—4,5,7



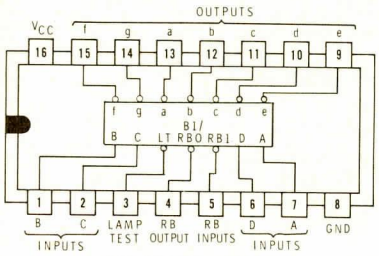
ECL 9528 ,95H28
DUAL D FLIP—FLOP

IC-8,1



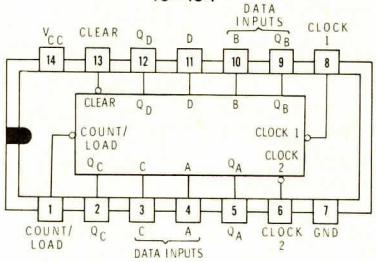
7403
POSITIVE NAN

IC—103,106,108,112,114,117,119



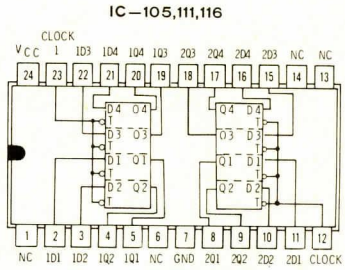
BCD-TO-SEVEN-SEGMENT
DECODER/DRIVER

IC—104



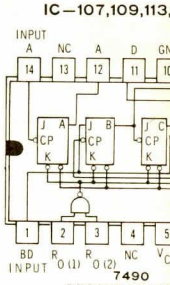
N8290A
DECADE COUNTER

IC—105,111,116



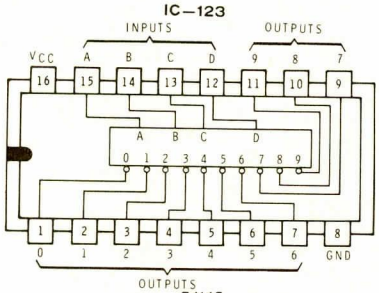
74100
8-BIT BISTABLE LATCH

IC—107,109,113,



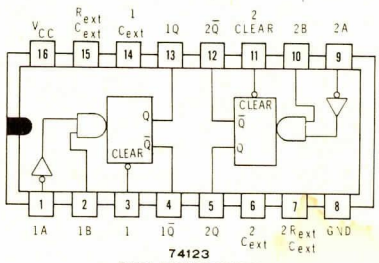
7490
DECADE COUN

IC—123



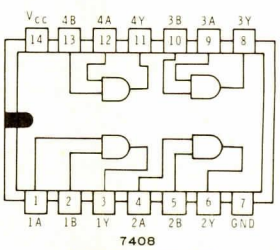
74145
BCD-TO-DECIMAL DECODER/DRIVER
(OPEN COLLECTOR)

IC—124,125



74123
DUAL MONOSTABLE

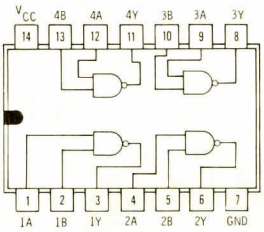
IC—126



7408
QUAD POSITIVE AND
GATES

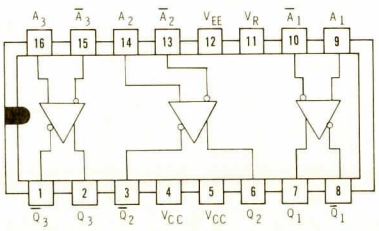
UIT BASE DIAGRAMS
VIEW)

IC-8,127



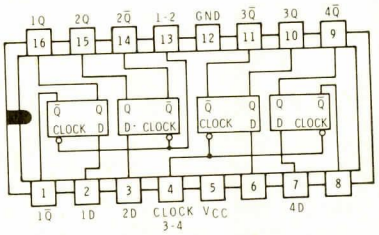
7403
POSITIVE NAND GATE

IC—101



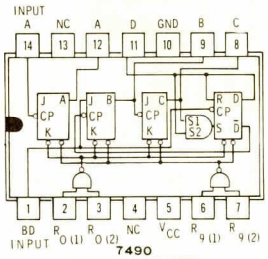
ECL 9582
LINE RECEIVER/AMPLIFIER

IC—102



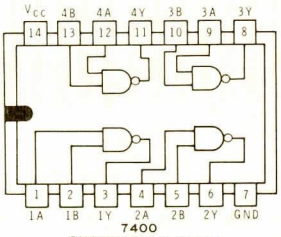
7475
4—BIT BISTABLE LATCH

IC—107,109,113,115,118



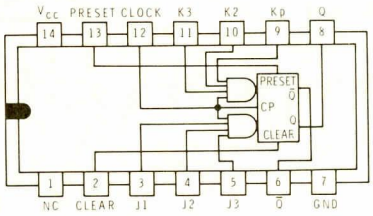
7490
DECADE COUNTER

IC—121



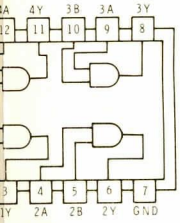
7400
QUADRUPLE 2-INPUT
POSITIVE NAND GATES

IC—122



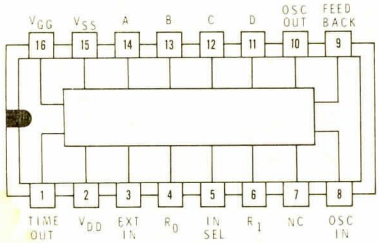
7472
J-K MASTER-SLAVE
FLIP-FLOP

IC—126



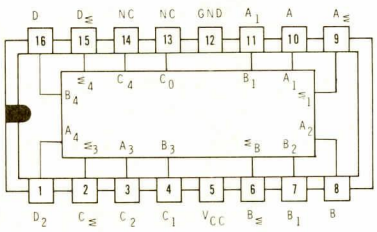
7408
AD POSITIVE AND
GATES

IC—128



MK5009P
OSCILLATOR—SCALER—
MULTIPLEXER

IC—129



7483
4-BIT BINARY FULL
ADDER

SERVICE INFORMATION

The following Heath Company services are available if you need them: Replacement Parts, Technical Consultation, and Factory Service. Address all correspondence to:

HEATH COMPANY
Benton Harbor, Michigan 49022

For prompt service, use a separate letter for each department you write to.

Replacement parts and repair service are also available at your nearest Authorized Service Center or Heath Electronic Center. These Centers are listed in your Heath Catalog.

REPLACEMENT PARTS

If a replacement part is needed, please include the following information in your letter:

1. Part number and description.
2. Model Number and Series Number of the equipment.

If your equipment is in the Warranty period, add:

3. Date of purchase.
4. Nature of defect.

Heath Company will fill your order promptly. Please DO NOT RETURN PARTS unless they are requested. Parts that are damaged through carelessness or misuse by the customer will not be replaced without cost.

TECHNICAL CONSULTATION

You can write to our Technical Consultants for help with any Heath equipment, or for answers to any questions about the use of this equipment.

The completeness and accuracy of the advice mailed back to you depends entirely on the information in your letter. Be sure to include:

1. The Model Number and Series Number of the equipment (on blue and white identification label).
2. Date of purchase.
3. An exact description of the difficulty. Include switch positions, connections to other units, operating procedures, voltage reading, and any other information you think might be helpful.
4. List everything you have done in attempting to correct the difficulty.

FACTORY SERVICE

If you do not have qualified repair services at your disposal, you can return your equipment to the Heath Company Service Department to have it repaired for a minimum service fee. (Equipment that has been modified will not be accepted for repair.) Refer to Shipping Instructions for details on how to package and ship the equipment.

To be eligible for replacement parts under the terms of the Warranty, equipment returned for factory service must be accompanied by the invoice or the sales slip, or a copy of either. (If you send the original invoice or sales slip, it will be returned to you.)

SHIPPING INSTRUCTIONS

Check the equipment to see that all parts are in place. Then, wrap the equipment in heavy paper. Place the equipment in a strong carton, and put at least three inches of resilient packing material (shredded paper, excelsior, etc.) on all sides between the equipment and the carton.

Seal the carton with gummed paper tape and tie it with a strong cord. Ship it by prepaid Express or insured Parcel Post to:

HEATH COMPANY
Benton Harbor, Michigan 49022

Attach a letter, containing the following information to the outside of the carton:

1. Your name and return address.
2. Date of purchase.
3. A brief description of the difficulty.
4. Your authorization to ship the repaired unit back to you C.O.D. for the service and shipping charges, plus the cost of parts not covered by the Warranty.

WARRANTY

The Heath Company warrants that under conditions of normal use and service it will repair or replace any factory assembled unit whose performance does not meet published specifications and is returned to Heath prepaid within one year following date of shipment. The published specifications are those labelled "specifications" in the catalog and the manual for the unit. The replacement or repaired unit is shipped prepaid by us anywhere in the continental United States or to APO or FPO addresses. Shipments to other places are FOB factory. Heath's obligation is limited to such replacement or repair by Heath, and Heath is not responsible under this warranty or otherwise for any consequential damage or other loss in connection with the unit or its use.

Questions relating to repairs or warranty replacement in the continental United States (APO and FPO included) should be addressed to Heath Company, attention: Customer Relations, or the nearest Heathkit Electronic Center. In all other areas please contact the authorized Heathkit representative in your country, or Heath Company, attention: International Division.

HEATH COMPANY
Benton Harbor, Michigan 49022

The Heath Company reserves the right to discontinue instruments and to change specifications at any time without incurring any obligation to incorporate new features in instruments previously sold.

7500

HEATH
Schlumberger

HEATH COMPANY
BENTON HARBOR, MICHIGAN 49022
PHONE 616-983-3961 TLX 72-9421

Dear Customer:

As you will notice when you examine the specification section of your SM-110 manual, the guaranteed upper frequency specification for the "B" input has been reduced from 200 MHz to 180 MHz. We sincerely regret this. However, the inability of our supplier to produce devices which will unconditionally meet our 200 MHz specification has forced us to take this course of action. You will notice that the typical specification has not been reduced from the originally advertised 230 MHz figure. The new 180 MHz figure represents, as did the original 200 MHz figure, a worst case temperature specification. We certainly hope that this slight reduction in worst case frequency capability will provide no measurement inconvenience to you. In the event that this change seriously affects your ability to utilize this instrument, please contact me personally so that arrangements may be made to rectify this situation.

We wish to thank you for your tolerance in such matters, especially in these times of almost continuous problems in obtaining high-quality components. We are sure that you will understand our desire to advise all users of a reduction in a limit specification rather than producing a marginal product.

Sincerely yours,

David E. Altwies

David E. Altwies
Sales Manager,
Assembled Instrumentation

Extension 207

591-1463